

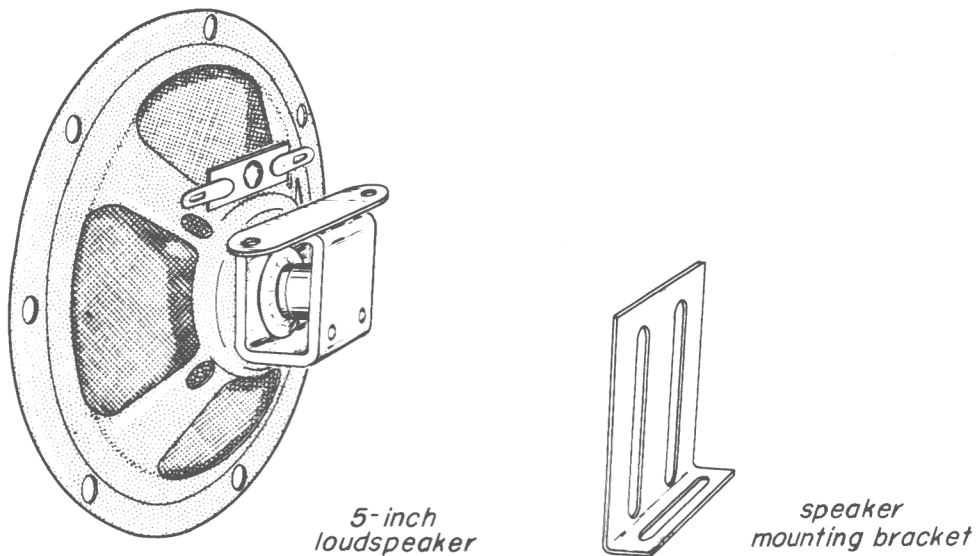
ELECTRONIC FUNDAMENTALS

EXPERIMENT LESSON 23

VOLTAGE-AMPLIFIER EXPERIMENTS



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All the parts in Kit 12 are listed below. Check the parts you receive against this list. Make sure you have the correct quantity of every item. If a part is either missing or defective upon arrival, request a replacement from Department R, Home Study School, RCA Institutes, Inc., 350 West 4th Street, New York 14, N.Y. *Your request must include your name and student number, the complete name and description of the part copied from the Item column below, the Quantity missing or defective, and the reason you are asking for a new part.*

KIT 12

BILL OF MATERIALS

Quantity	Item
1	6K6-GT electron tube
1	Potentiometer, 500 k ohms
1	Resistor, 470 k ohms, 1/2 watt
1	Capacitor, 270 $\mu\mu\text{f}$ 500 wv
1	5-inch loudspeaker
1	Audio output transformer
1	Speaker mounting bracket
5'	Hookup wire
3.5'	Nichrome wire

If you get a part slightly different from a part described in this list, the substitute part will not interfere electrically or mechanically with your experiments or equipment.

Experiment Lesson 23

OBJECT

1. To construct and study some voltage-amplifier circuits.
2. To construct the voltage-amplifier stage of the radio receiver.

INFORMATION

Lesson 19 demonstrated the ability of a triode electron tube to amplify signals. In Experiment Lesson 22 you determined the characteristics of the triode section of the 6AT6 tube. In this lesson you will use the 6AT6 triode in various voltage-amplifier circuits, and study the properties of voltage amplifiers in more detail. Theory Lesson 23 discusses how voltage amplifiers are used to increase the strength of weak signals. In a radio receiver, such as the one you are building, the voltage amplifier is used to amplify the weak detector output. Voltage amplifier stages may also be used as microphone or phonograph-pickup amplifiers. If the output of the voltage amplifier is used to operate another voltage amplifier, the two-stage amplifier is called a cascaded amplifier. When the output is used to operate a power amplifier, such as the 6K6-GT that drives the loudspeaker in your receiver, it may also be called a *driver stage*.

EQUIPMENT NEEDED

Receiver chassis (as wired at the end of Experiment Lesson 22)

Signal generator

Multimeter

1,000-ohm 5-watt resistor

10 k-ohm 1/2-watt resistor (from Kit 1)

22 k-ohm 2-watt resistor (on chassis)

47 k-ohm 1-watt resistor (on chassis)

Four 100 k-ohm 1/2-watt resistors (two from Kit 8, one on resistor board, one from Kit 1)

10-megohm 1/2-watt resistor (from Kit 6)

Two 1.5-volt dry cells

2-lug terminal strip (from previous experiments)

Alligator clip lead

Soldering iron and solder

Hand Tools

Hookup wire

Capacitor board

Note: The word *connect*, as it is used in this lesson, means make a temporary soldered connection.

Figure 23-1 shows your receiver chassis as it looked at the end of Experiment Lesson 22. If you have made any changes in the wiring, rewire the circuit so that it looks like the figure.

JOB 23-1

To prepare the receiver chassis for Experiment 23-1.

Procedure.

Step 1. Remove and put aside the 47 k-ohm resistor connected to the potentiometer, and the 10 k-ohm and 22 k-ohm resistors connected to TS-C. Replace the 10 k-ohm resistor on the resistor board.

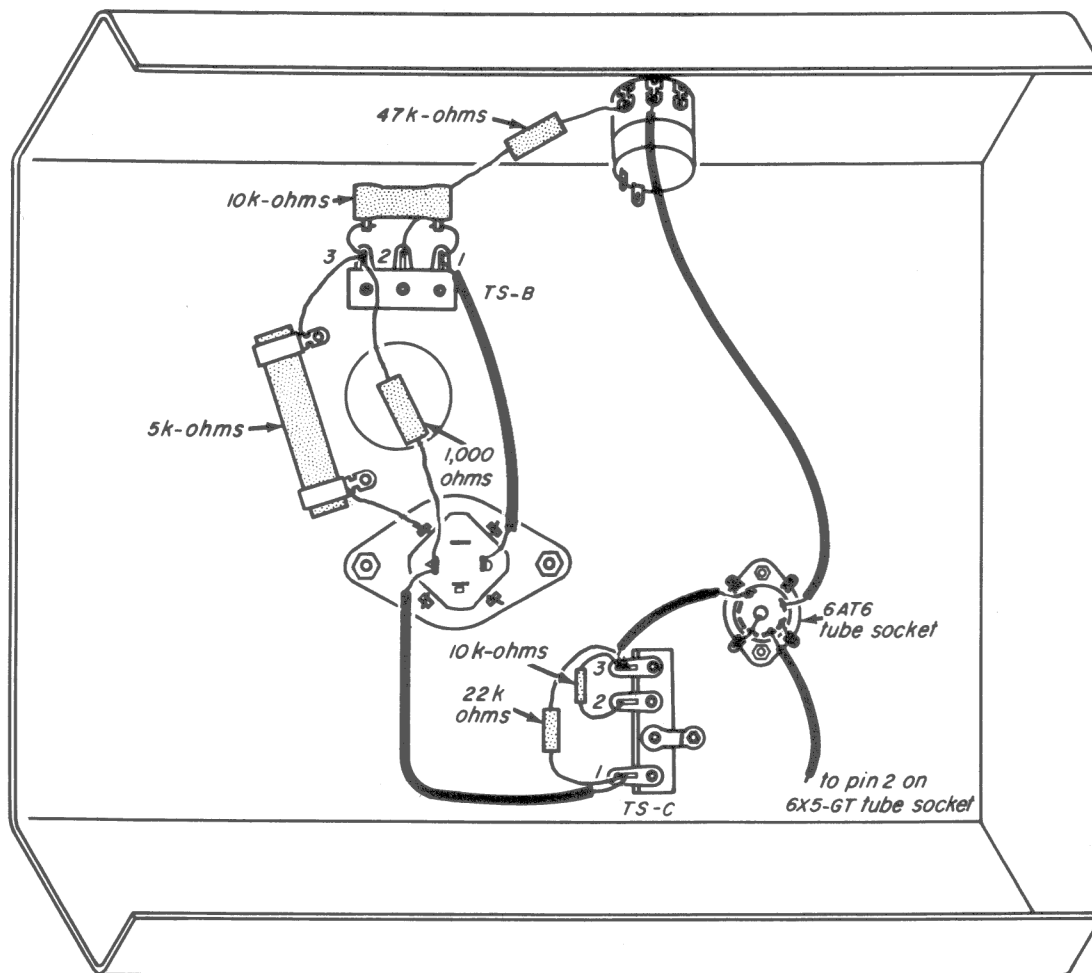


Fig. 23-1

Step 2. Remove the wire that connects the potentiometer with pin 1 on the tube socket.

Step 3. Disconnect the 5 k-ohm and the 10 k-ohm resistors and reverse their positions. (Connect the 5 k-ohm resistor between lugs 1 and 3 of TS-B. Connect the 10 k-ohm resistor between lug 3 of TS-B and ground.)

Step 4. Connect a 100 k-ohm resistor between lugs 1 and 3 of terminal strip TS-C.

Step 5. Install a 2-lug terminal strip with a 6-32 x 1/4" machine screw and nut in the position shown in Fig. 23-2a. This terminal strip will be referred to as TS-D.

Step 6. Connect one lead of the 10-meg-ohm resistor to pin 1 of the tube socket. Connect the other lead to lug 1 of terminal strip TS-D.

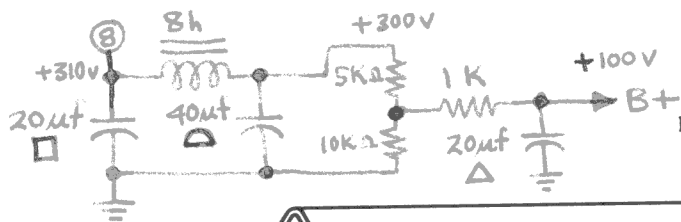
Step 7. Connect a short piece of wire across lugs 1 and 2 of TS-D.

Step 8. Connect a piece of bare wire between lug 2 of TS-D and the ground lug below pin 1 of the 6AT6 tube socket.

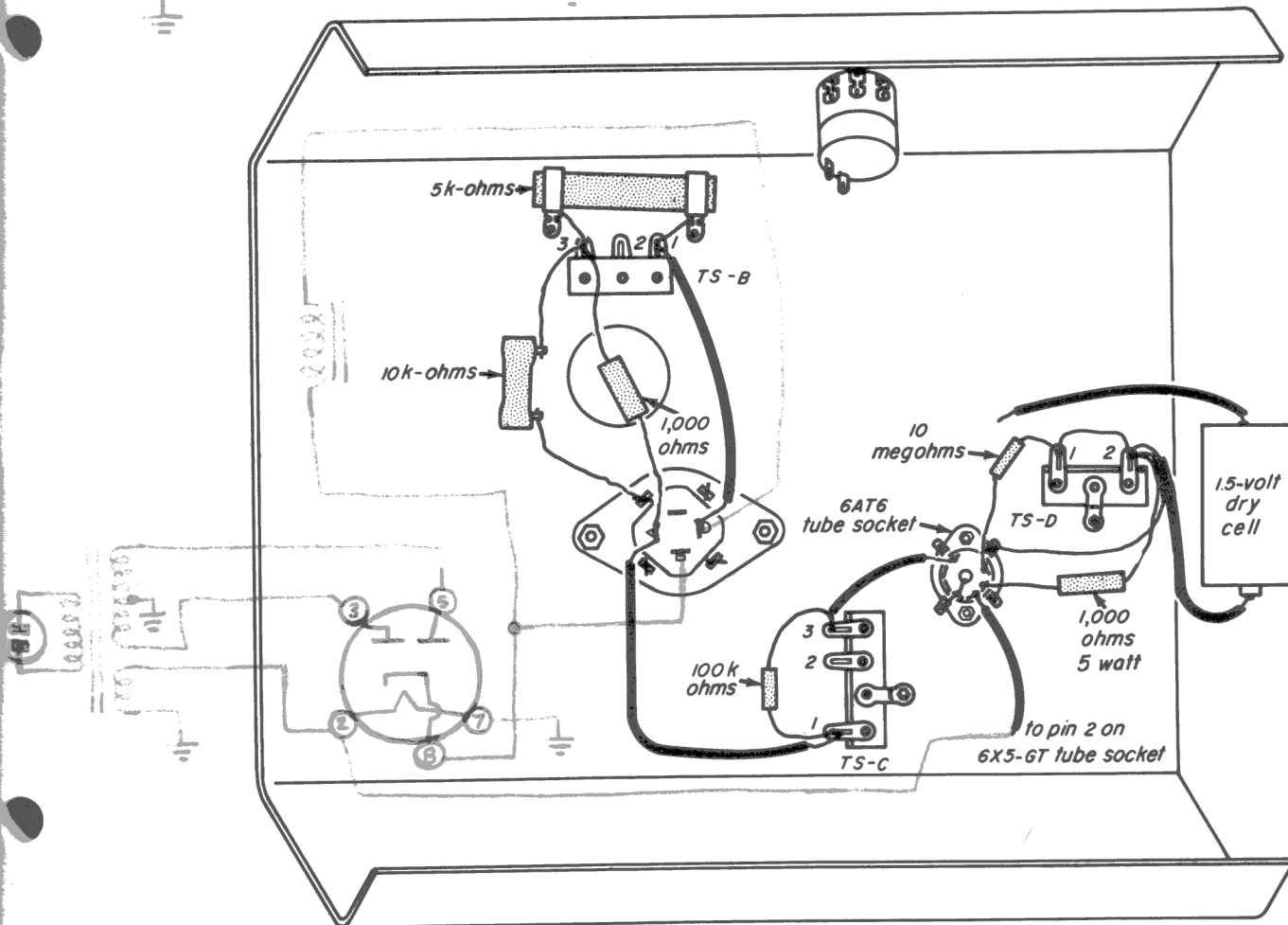
Step 9. Remove the short piece of wire connecting pin 2 of the 6AT6 socket to the ground lug, and connect a 1 k-ohm resistor between pin 2 of the tube socket and lug 2 of TS-D.

Step 10. Connect a 4-inch piece of hookup wire to the positive and negative terminals of a 1.5-volt dry cell. Solder the positive lead to lug 2 of terminal strip TS-D. The negative lead is left free.

Step 11. Check your work closely with the drawing in Fig. 23-2a, which shows the new wiring added, and the schematic in Fig. 23-2b. Make sure your chassis agrees with this figure.



Experiment 23-1



EXPERIMENT 23-1

To study the phase relationship between grid and plate and grid and cathode in a voltage amplifier.

To show that the voltage changes developed across the plate and cathode load resistors are opposite in polarity; that is, to show that changes of voltage at the cathode follows the voltage changes in the grid circuit, while the voltage changes at the plate are opposite in direction from changes in the grid circuit.

Procedure.

Step 1. Plug in the receiver power cord and allow about 30 seconds for the tubes to warm up.

Step 2. Set up the meter on the 500 VDC

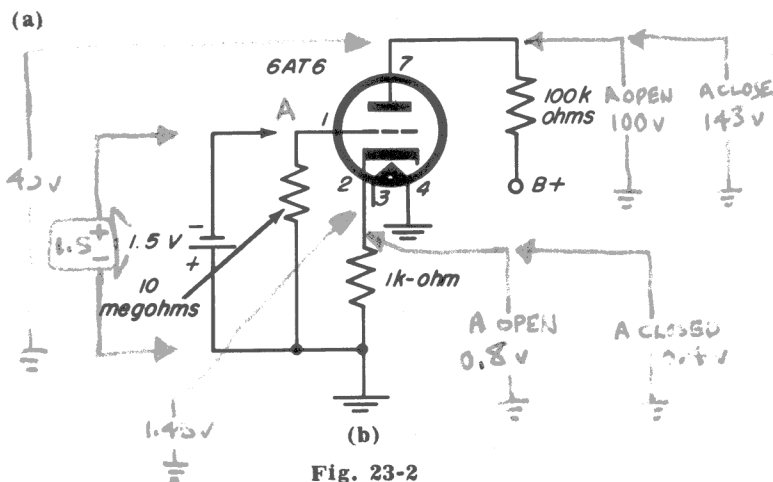


Fig. 23-2

range and connect it to measure the voltage between plate and ground.

Step 3. Measure the plate voltage and record it here:

100
volts d.c.

Step 4. Touch the free lead of the battery to pin 1 of the 6AT6 tube socket. Record the plate voltage reading here.

143
volts d.c.

Step 5. Change the meter to the 5 VDC range and measure the cathode to ground voltage. Record the voltage here:

.8
volts d.c.

Step 6. Touch the free lead of the battery to pin 1 of the 6AT6 tube socket. Record the result here:

.4
volts d.c.

Step 7. Unplug the line cord, reverse the leads of the dry cell, and repeat Steps 1 and 2.

Step 8. Touch the free lead of the cell to pin 1 of the 6AT6 tube socket. Note the plate voltage reading and record it here.

45
volts d.c.

Step 9. Change the meter to the 5 VDC range, touch the free lead of the cell to the grid, and measure the cathode to ground voltage. Record the result here:

1.45
volts d.c.

Step 10. Unplug the line cord.

Examine your voltage readings in Steps 3 to 9, and complete the blanks in the following sentences with *more*, or *less*.

Making the grid more negative makes the plate more positive.

Making the grid more negative makes the cathode less positive.

Making the grid more positive makes the plate less positive.

Making the grid more positive makes the cathode more positive.

Discussion. In this experiment, the plate voltage is about 90 volts, and the cathode voltage is about 1 volt. When the negative end of the 1.5 volt dry cell is touched to the grid, this makes the grid go more negative. As a result, the plate voltage increases, or goes more positive, but the cathode voltage decreases, or goes less positive. This is because making the grid negative decreases the current flow through the tube, and there is less of a drop of voltage in the plate-load resistor. Since the plate voltage is the supply voltage minus the drop in the plate load resistor, this makes the plate voltage higher. On the other hand, the voltage at the cathode is due to the current flow through the cathode resistor, and reducing the current flow through the tube reduces this voltage.

The opposite results are obtained when the battery is wired into the circuit with reversed polarity. These results are summarized here:

1. Making the grid more negative makes the plate more positive.
2. Making the grid more negative makes the cathode less positive.
3. Making the grid more positive makes the plate less positive.
4. Making the grid more positive makes the cathode more positive.

Since the plate-voltage change is always opposite to the cathode-voltage change, the signal voltages at the plate and cathode are 180 degrees out of phase. (This is true only when the plate load is a resistive load.)

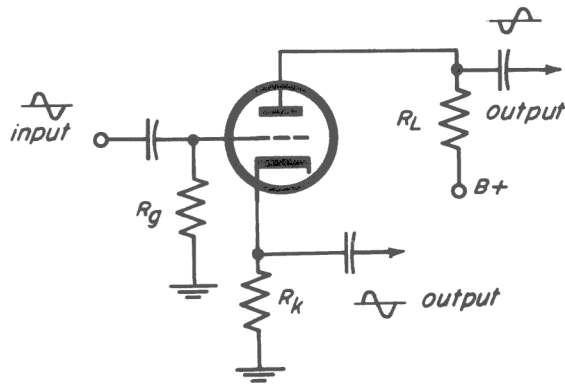


Fig. 23-3

We use this principle in order to obtain two voltages that are equal but opposite in phase. Two equal loads are placed in the plate and cathode circuits of an amplifier, as in Fig. 23-3. The voltages at the plate and cathode are equal in amplitude but opposite in polarity or 180 degrees out of phase with each other. Such an amplifier circuit is called a *phase splitter*.

The output of an amplifier stage is usually taken from the plate circuit. Sometimes, however, it is desired to avoid the phase reversal that takes place between the grid and plate of an amplifier stage. This can be done by putting the load in the cathode circuit of the amplifier, as shown in Fig. 23-4. This circuit is called a *cathode follower*. It has the additional advantages of having a very high input impedance, and very low effective input capacity. As usually used, it has the disadvantage of having a gain of less than one, as we shall see in a later experiment.

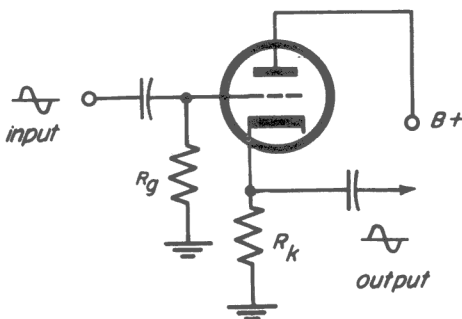


Fig. 23-4

EXPERIMENT 23-2.

To show the effect of putting the load of an amplifier stage in the cathode circuit.

Information. The load of an amplifier circuit is almost always placed in the plate circuit. This is so except in special amplifier circuits, such as cathode followers or phase splitters, which will be studied later. In fact, the amplifier load is usually called the plate load. The circuit of Fig. 23-5 shows that the plate and cathode circuits of the amplifier are all in series, as shown by the heavy lines. From this figure, you might assume that the amplifier load could be placed anywhere in this series circuit, and the same a-c output voltage would be developed across it. However, this experiment will show that, for maximum voltage output, the load should be placed in the plate circuit, and not in the cathode circuit.

Procedure.

Step 1. Plug in the signal generator and allow it to warm up. Connect the signal-generator cable to the AF OUTPUT connector, and set the signal generator bandswitch to Band X.

Step 2. Set the meter on the 75 VAC range and connect the meter leads across the signal generator cable. Adjust the AF OUT/INT MOD control to obtain a reading of 10 volts on the meter.

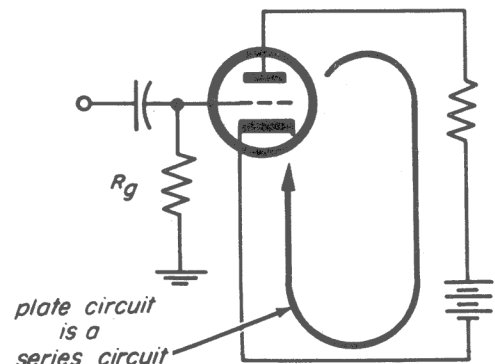


Fig. 23-5

Step 3. Remove the jumper across lugs 1 and 2 of TS-D, and connect the negative lead of the battery to lug 1 of TS-D, and the positive lead of the battery to lug 2 of TS-D.

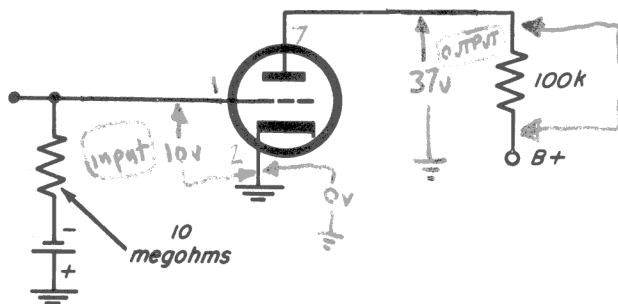


Fig. 23-6

Step 4. Remove the 1,000-ohm resistor and connect pin 2 of the 6AT6 socket to the ground lug.

Step 5. Connect the "hot" lead (center conductor) of the signal generator to the grid (pin 1) of the 6AT6 tube socket and connect the ground lead of the cable to the chassis. The 10-volt signal applied to this tube is much more than this tube can handle, and the output is very distorted, and the voltage measurements are therefore not accurate. Both of these facts are neglected in this experiment.

Step 6. Check your work with the schematic shown in Fig. 23-6. If everything is correct, plug in the power cord and wait about 30 seconds for the tubes to warm up.

Step 7. Check to see that your meter is set up to read a-c voltage on the 75 VAC range, and the red lead is in the output jack.

Measure the voltage from plate to ground. Record your reading here:

37
volts a.c.

Measure the voltage from cathode to ground. Record your reading here:

0
volts a.c.

Measure the voltage from grid to cathode. Record your reading here:

10
volts a.c.

Step 8. Disconnect the power cord. Short out the plate load resistor by connecting a short piece of bare wire between lugs 1 and 3 of TS-C.

Step 9. Remove the short between pin 2 of the 6AT6 tube socket, and the grounding lug, and connect a 100 k-ohm resistor between pin 2 and the grounding lug.

Step 10. Check your work against Fig. 23-7, and if everything agrees, plug in the power cord.

Step 11. After the tubes have warmed up repeat the grid to cathode measurements you made in Step 7, with the meter on the 15 VAC range, and record them here:

grid to cathode
5.0
volts a.c.
cathode to grid
Expanded 7.6
100V 15V
100V A.C.

Step 12. Measure the input voltage and record it here:

grid to gnd
10
volts a.c.

Step 13. Unplug the power cord.

Discussion. In this experiment, you noticed that the output voltage across the same load resistance is many times higher than the input voltage when the load is in the plate circuit, but less than the input voltage when that load is put in the cathode circuit. Typical voltage readings when the signal generator output is adjusted to 10

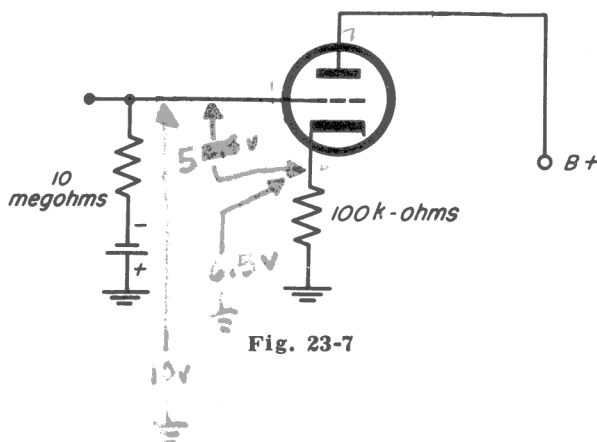


Fig. 23-7

VAC are about 30 volts across the load when it is in the plate circuit, and 6 volts when it is in the cathode circuit.

In order to see why this happens, you measured the actual voltage between grid and cathode of the tube, the voltage from cathode to ground, and the signal generator output, which in this case is the voltage from grid to ground. You found that, even though the signal generator output is 10.0 volts, the actual voltage between grid and cathode of the tube is only 4.0 volts. The difference in these two voltages appears across the resistor on the cathode, which is 6.0 volts.

The current through the tube is controlled by the *net voltage* between grid and cathode of the tube. Let us see what the effect the voltage across the cathode resistor has on this net voltage.

The a-c voltage across the cathode resistor is developed by the a-c plate current flowing through it. The instantaneous polarity of the voltage at the cathode end of the resistor is the same as the polarity of the grid voltage. (This was shown in the previous experiment, which demonstrated that the cathode voltage *follows* the grid voltage.) Figure 23-8a shows the polarity of the grid voltage and the cathode voltage at any one instant. When this is redrawn as in Fig. 23-8b, it can be seen that, as far as the *net voltage* between *grid and cathode* is concerned, the input voltage is opposed by the voltage across the cathode resistor. This opposition is called *degeneration*. Its effect is to reduce the actual input voltage applied between grid and cathode of the tube and thus considerably reduce the voltage amplification of the stage. Therefore, whenever maximum voltage amplification is desired from an amplifier stage, the load is connected in the plate circuit.

As previously mentioned, the load is sometimes placed in the cathode circuit. This is done to avoid the phase reversal in the plate circuit, or for other reasons that will be described later in the course. Sometimes resistors are put into the cathode circuit to

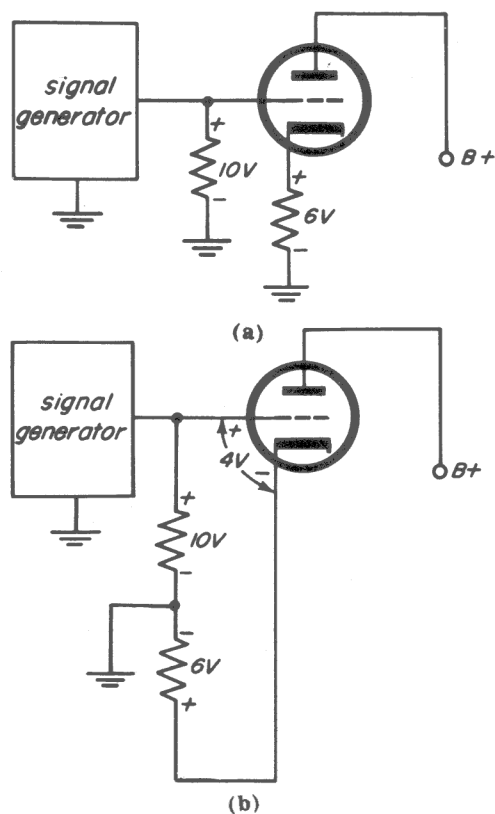


Fig. 23-8

obtain a small amount of degeneration, which improves certain features of amplifier operation. This will be discussed further later in this course.

A certain type of power output amplifier known as a push-pull amplifier requires input signals that are equal but opposite in polarity, or 180 degrees out of phase. These two equal-amplitude but opposite-polarity signals may be provided by a center-tapped transformer or various forms of amplifier circuits. One form of amplifier circuit for this purpose is shown in Fig. 23-3. The amplifier load is equally divided between plate and cathode circuits. As demonstrated in the previous experiment, degeneration causes the gain to be less than one. However, two equal opposite-polarity signals are obtained—one across the plate load and the other across the cathode load.

EXPERIMENT 23-3

To show that a signal may be inserted either into the grid circuit when the cathode is grounded or into the cathode circuit when the grid is grounded.

Procedure.

Step 1. Remove the short from between lugs 1 and 3 of TS-C.

Step 2. On the resistor breadboard, connect the 1 k-ohm and the 100-ohm resistors in series.

Step 3. Cut two 18-inch pieces of hookup wire, and with one piece connect the open end of the 1 k-ohm resistor to pin 2 of the 6X5-GT tube socket. With the other piece, connect the open end of the 100-ohm resistor to one of the ground lugs on the 6AT6 tube socket.

Step 4. Remove the 100 k-ohm resistor from the cathode circuit and the 1.5-volt dry cell from the grid circuit of the 6AT6 tube.

Step 5. Connect one end of your clip lead to the junction of the 1 k-ohm and the 100-ohm resistors. The other end clips to the grid (pin 1) of the 6AT6 tube socket.

Step 6. Connect the 1.5-volt dry cell in the cathode circuit with the positive terminal going to the cathode (pin 2) and the negative terminal going to ground.

Step 7. Connect a short piece of bare wire between lugs 1 and 2 of TS-D.

Step 8. Check your circuit against the schematic shown in Fig. 23-9. If it agrees, plug in the power cord and wait about 30 seconds for the tubes to warm up.

Step 9. Measure the output voltage across the plate load resistor and record it here:

22
volts a.c.

Step 10. Disconnect the clip lead from the resistor board, and connect it to the chassis, so as to ground pin 1 of the 6AT6 tube socket.

Step 11. Remove the negative terminal wire of the dry cell from ground and connect

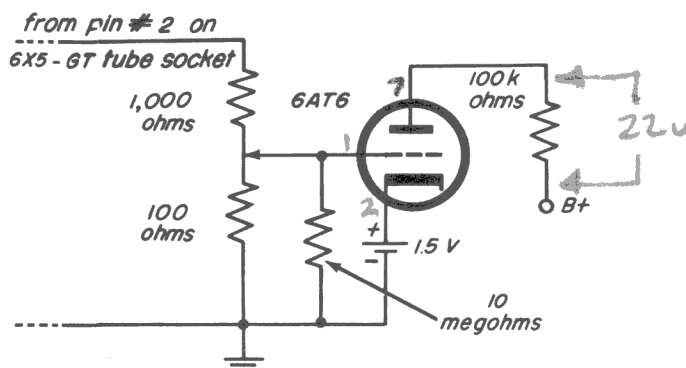


Fig. 23-9

this wire to the junction of the 1 k-ohm and 100-ohm resistors on the board.

Step 12. Check your work with the schematic shown in Fig. 23-10. Then plug in the power cord and allow the tubes to heat up.

Step 13. Measure the voltage developed across the plate load resistor and record it here:

21.5
volts a.c.

Discussion. In this experiment, you first injected a signal into the grid circuit, with the cathode at a-c ground (the dry cell has very low internal impedance to the signal), then into the cathode circuit with the grid circuit grounded. The voltage in both cases should be approximately 22.5 volts a.c. Your readings may vary from the above values due to slight differences in line voltage or component values, but the two readings that you get should be within a very small per-

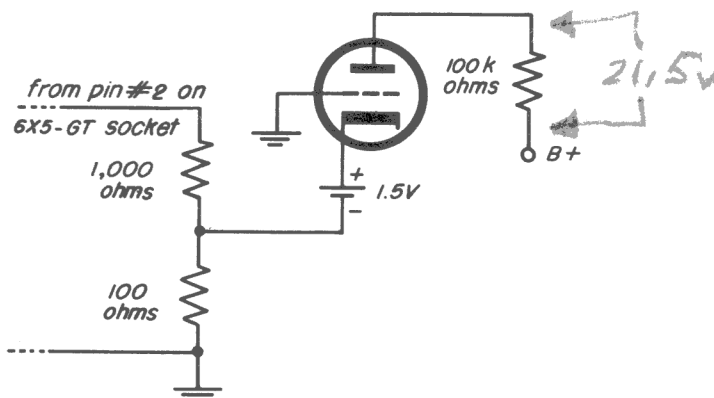


Fig. 23-10

centage of each other, proving that the signal can be inserted into either the grid circuit or the cathode circuit, and the gain is the same in each case.

EXPERIMENT 23-4

To study how the gain of a voltage amplifier changes as the plate-load resistance varies.

Procedure.

Step 1. Disconnect the 1.5-volt dry cell and resistor breadboard and put them aside, and ground the cathode with a short piece of wire.

Step 2. Remove and put aside the clip lead from between the grid and ground.

Step 3. With short lengths of hookup wire, connect the 100 k-ohm, the 10 k-ohm, and the 1 k-ohm resistor on the resistor breadboard in series.

Step 4. Turn the signal generator on, and allow it to warm up. Set the multimeter up on the 15 VAC range, and connect it across the terminals of the signal generator cable. Adjust the AF OUTPUT control to obtain exactly 1.0 volt a.c.

Step 5. Connect the output of the signal generator across the three series resistors on the resistor breadboard, with the ground lead going to the free end of the 1 k-ohm resistor. The other lead goes to the free end of the 100 k-ohm resistor, as shown in Fig. 23-11.

Step 6. Connect a 12-inch piece of wire from the junction of the 10k-ohm and the 100k-ohm resistors to one terminal of the 0.25- μ f capacitor on the capacitor board, and another piece of wire from the other terminal of this capacitor to pin 1 of the 6AT6 tube socket, as in Fig. 23-11.

Step 7. Connect your clip lead jumper between the ground side of the 1 k-ohm resistor and the receiver chassis.

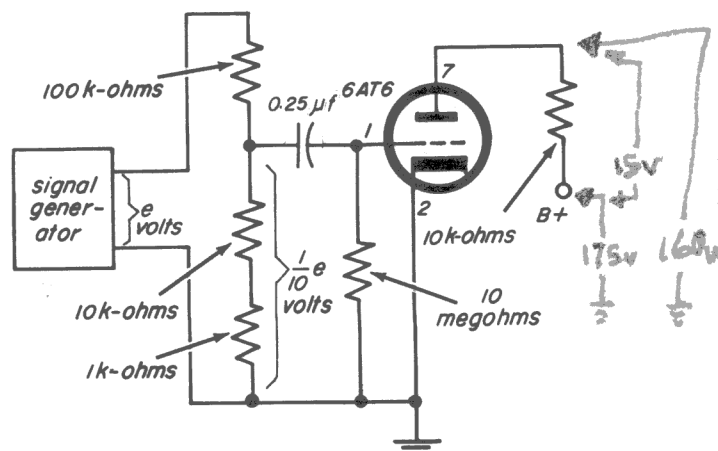


Fig. 23-11

Information. The circuit for this experiment is shown in schematic form in Fig. 23-11. Two functions are performed by the three series resistors: They form a 10:1 voltage divider, so that with 1 volt input, 0.1 volt is applied as signal to the grid of the 6AT6 tube. Also their total resistance is the same as that of the meter on the 15 VAC range, so they duplicate the meter loading and keep the voltage input constant.

The 0.25- μ f capacitor serves as a coupling capacitor. It passes the signal, and prevents the contact bias (explained later) from being shorted out.

Step 8. Remove the 100 k-ohm plate load resistor and connect a 10 k-ohm resistor in its place.

Step 9. Check your work with the schematic in Fig. 23-11. When you are sure the work is correct, plug in the power cord, and wait about 30 seconds for the tubes to warm up.

Step 10. Measure the d-c plate voltage and the a-c output voltage and record them in the appropriate place in Table A. Change the plate load to the other values shown in the first column of Table A and measure and record d-c plate voltage and a-c output voltage for each value. Do this for all of the values shown.

Step 11. Unplug the power cord.

Step 12. Using the following formula, fill

TABLE A

max load 180k

4.2

Plate Load Resistance (ohms)	Plate D-C Voltage Plate to gnd	A-C Output plate to gnd.	Gain = (Output ÷ Input)
10,000	155v	1.5v	15
22,000	135v	2.6v	26
32,000 (10k + 22k)	128v	3v	30
47,000	117v	3.4v	34
57,000 (47k + 10k)	112v	3.6v	36
69,000 (47k + 22k)	105v	3.8v	38
79,000 (47k + 22k + 10k)	101v	3.9v	39
100,000	96v	4.1v	41
200,000 (100k + 100k)	78v	4.2v	42
300,000 (100k + 100k + 100k)	70v	4.1v	41
500,000 (Potentiometer)	60v	3.8.	38

15
1

in the last column of Table A for each value of plate load resistance.

$$\text{gain} = \frac{\text{output voltage}}{\text{input voltage}}$$

Step 13. On the graph paper, at the end of this lesson, plot a graph of gain versus plate-load resistance. If you have any difficulty with the graph, reread the section on graphs in Lesson 16.

What is the highest gain?

How does it compare with the amplification factor of the 6AT6 tube?

Discussion. In this experiment, you found that the gain rose as you increased the plate load resistance until the load was increased to 200 k-ohms; then the gain started to drop off again. Typical results are shown in Table B and Fig. 23-12. The a-c voltage in an amplifier divides between the tube's plate resistance and the load resistance. As the load resistance is increased in proportion to the tube's plate resistance, more and more of the a-c output voltage appears across the load resistance. This is explained by the principles of voltage dividers, which you have studied.

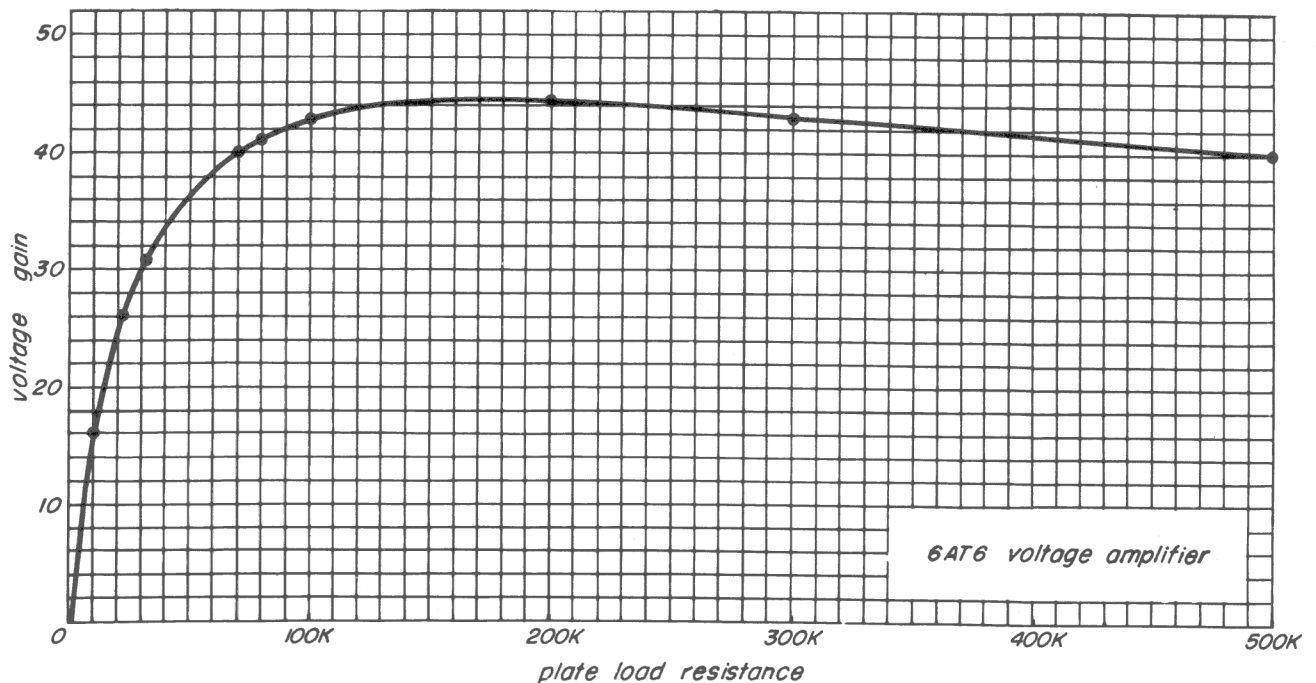


Fig. 23-12

However, the a-c output voltage across the load resistance cannot rise indefinitely as the load is increased, because the d-c plate voltage is reduced as the load resistance is increased. In this case, the voltage begins to fall again at 200 k-ohms, because the plate voltage has dropped to below 70 volts d.c.

No external bias is used in these voltage-amplifier circuits. About 1.0 volt is developed across the 10-megohm resistor due to contact bias (which you will study in a later lesson). This is sufficient bias voltage for the 6AT6 tube. Examination of the 6AT6 characteristic curves, which are shown in Fig. 23-13, will show that the curved labeled -1 begins to curve excessively below 70 volts. This explains why the gain drops off below this point. Thus, the maximum gain of an amplifier depends upon the plate-supply voltage and the grid bias voltage, as well as the plate-load resistance.

EXPERIMENT 23-5.

To predict the output of the 6AT6 tube from a load line, and verify the results by experiment.

Introduction. In this experiment, you will study how the tube characteristic curves, in combination with the correct load line, show in detail the exact operation of an amplifier stage. You will draw a load line for your voltage-amplifier circuit on the 6AT6 characteristic curves given in Fig. 23-13. You will use this load line to predict what the amplifier output will be with a 1-volt peak input signal. Then you will check your predicted results by actually applying a 1-volt peak input signal to your amplifier, and measuring the output voltage.

The 1-volt peak signal for the experiment is obtained by putting 7 volts rms (as measured by your meter) across your 10:1 voltage divider, giving a 0.7 volt rms output. But since the peak voltage is 1.414 times the rms voltage, this signal is a 1 volt peak signal.

Procedure.

Step 1. Remove the 500 k-ohm potentiometer from the plate circuit and replace it with one of the 100 k-ohm resistors. Try to draw the load line for a 100 k-ohm plate load using the information given in your theory lesson. If you are not sure of the procedure, follow the steps below.

TABLE B

Plate Load Resistance (ohms)	Plate D-C Voltage	A-C Output	Gain = (Output ÷ Input)
10,000	160	1.6	16
22,000	140	2.6	26
32,000 (10k + 22k)	130	3.1	31
47,000	115	3.6	36
57,000 (47k + 10k)	110	3.8	38
69,000 (47k + 22k)	103	4.0	40
79,000 (47k + 22k + 10k)	100	4.1	41
100,000	96	4.3	43
200,000 (100k + 100k)	77	4.4	44
300,000 (100k + 100k + 100k)	68	4.3	43
500,000 (Potentiometer)	60	4.0	40

Step 2. Compute the amount of current ($B+ \text{ supply voltage} \div 100 \text{ k-ohms}$) that would flow through the 100 k-ohm resistor if the plate were shorted to ground. Turn to the 6AT6 plate characteristics graph (Fig. 23-13) and mark this point with a sharp pencil.

Step 3. Mark the graph on the horizontal baseline at the point showing the amount of $B+$ supplied to the tube.

Step 4. Draw a straight line connecting these two points together and mark the point where this line crosses the -1.0 volt curve.

Step 5. Draw a line straight down from the 0 volts line and another from the -2.0 volts line to the bottom of the graph. Determine how much the plate voltage swing is between these two lines and record it here:

85
volts peak-
to-peak a.c.

Divide this value by 2 to get the peak value, and then multiply your answer by 0.707 to

6AT6 AVERAGE PLATE CHARACTERISTICS TRIODE UNIT

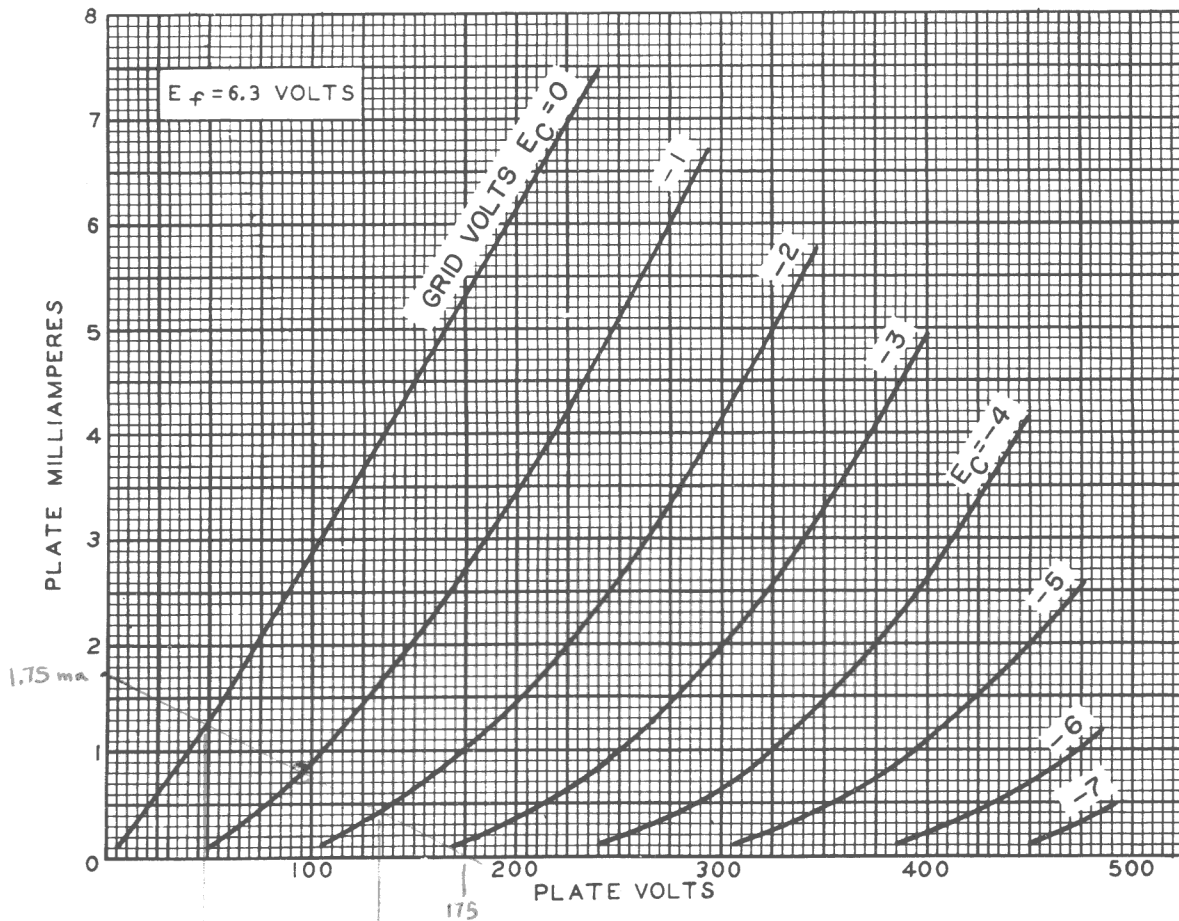


Fig. 23-13

get the rms value. Record your calculated result here:

30.4
volts a.c. rms

Now let's apply a 1-volt peak signal to the tube, and measure the actual output obtained:

Step 6. Connect your meter on the 15 VAC range across the signal-generator cable, and adjust the output to 7.1 volts. Put your signal generator across the divider network and connect the divider network between grid and ground, as you did in Experiment 23-4, Steps 5 to 7.

Step 7. Measure the output voltage a-

cross the plate load resistor and record it here:

40 volts a.c. rms 30%

Step 8. Compare the two values you obtained. If they are not within about 20% of each other, check your graphical work and also measure the voltage out of the signal generator and across the plate load resistor again carefully.

Step 9. Unplug the power cord. Disconnect and put aside the capacitor board and the voltage divider.

Discussion. The load line that you drew on the 6AT6 characteristic curves for a 100 k-ohm load and 200 VB+ should appear like the one shown in Fig. 23-14. This load line shows the variations in plate current and plate voltage produced by voltages applied to the grid. We can use this load line to calculate or predict what the output will be when

6AT6 AVERAGE PLATE CHARACTERISTICS TRIODE UNIT

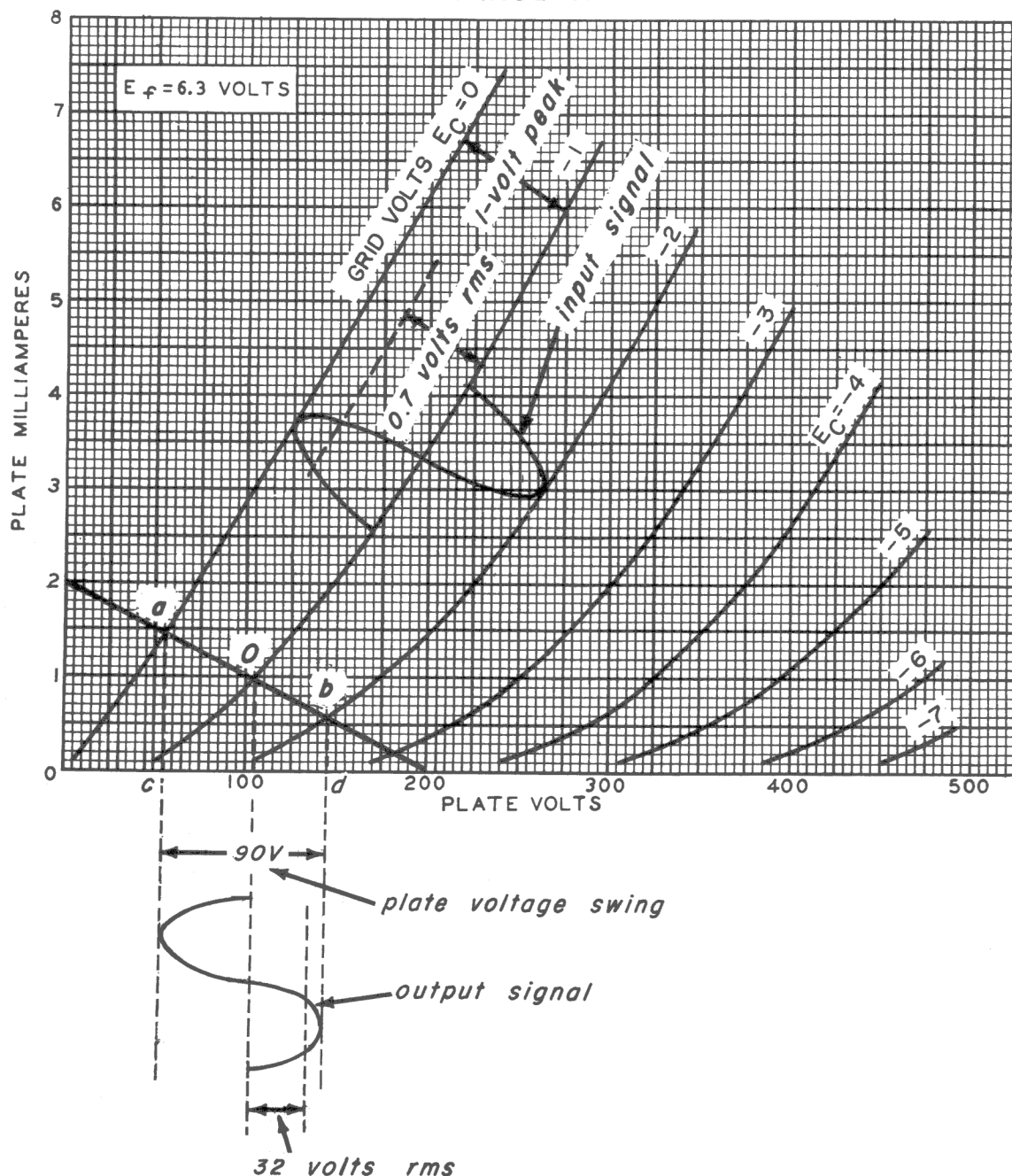


Fig. 23-14

a 1-volt peak signal is applied to the tube. A 1-volt peak signal applied in series with a -1.0-volt bias (produced by contact bias) will vary the peak grid voltage from 0 volts to -2.0 volts, as shown at points *a* and *b* in Fig. 21-14. The plate voltage corresponding to a positive peak grid voltage of 0 volts is 55 volts, as shown at *c*, and the plate voltage corresponding to a

negative peak grid voltage of -2.0-volts is 145 volts, as shown at *d*. The difference between these two voltages, or 90 volts, is the peak-to-peak voltage swing at the plate. Dividing this in half gives the peak voltage, which is 45.0 volts. However, your meter does not indicate peak voltage, but the rms voltage. To find the rms voltage, multiply the peak voltage by 0.707, which in this

case gives 31.8 volts as the voltage which the meter will read.

To check our calculated answer by actual measurement, we have to apply to the grid a 1-volt peak signal. This is done by setting the signal generator output to 7.1 volts. When this is applied to the 10:1 voltage divider, a 0.71 volt signal is applied to the tube. But a 0.71 volt rms signal is a 1 volt peak signal. (Peak voltage = rms voltage $\times$ 1.414). Thus the signal applied to the tube is the same signal used in our calculations. The a-c output signal across the plate-load resistor measured in our laboratory was 30 volts. Thus you can see the usefulness of

tube-characteristic charts and the load line in predicting the operation of an amplifier circuit.

Since the actual tube characteristics may be different from the curves shown, some deviation between the predicted and experimental results should be expected.

It should be noted that the positive plate voltage swing (from point 0) is less than the negative plate voltage swing (from point 0). This indicates distortion of the output signal, due to excessive signal input. A 1-volt peak signal is used in this experiment, for convenience, but usually much smaller input voltages are used with the 6AT6 tube.



6AT6 Voltage Amplifier

